ANATOMY OF ADULT QUEEN AND WORKERS OF ARMY ANTS *ECITON BURCHELLI* WESTW. AND *E. HAMATUM* FABR. (HYMENOPTERA: FORMICIDAE)

Roy M. Whelden
Haskins Laboratories
New Durham, New Hampshire

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ABSTRACT

Forty-four queens (including five callows), several hundred workers of the polymorphic series, and males of the two species are studied, covering all systems but with particular attention to glandular cytology as between queens and workers. The post-pharyngeal gland of the queen fills most of the head cavity anterior to the brain; that of the worker is smaller but similar. Small glands at the bases of the legs contain increasing numbers of cells through the polymorphic series; most of all in the queen. The metasternal gland is conspicuous in the queen's thorax but not so in the worker's; the poison glands of the queen are larger than in the worker and present still other differences. The reproductive system of the queen is described in terms of differences in specimens collected at various points in the functional cycle of the colony, also in terms of differences between callow and functional queens and in contrast to the simple system of workers. Differences in the muscular, nervous and respiratory systems of queen and worker are described. In dorylines these last systems are similar to those in other ants except for secondary details related to physogastry in the queen. Included are 17 detailed plates.

INTRODUCTION

Many papers have been written on the anatomy of ants. In his book (Ants, 1926) Wheeler summarized the papers published before that date, and gave a complete bibliography of such papers. The relatively few papers on ant anatomy that have appeared since deal mainly with myrmicine and formicine ants. Ponerine ants have been less frequently described. Papers describing the anatomy of doryline ants have appeared infrequently.

In these papers, only a few consider the genus *Eciton*, and each of these limits itself to some particular structure. The earliest of these papers, that of Miss Holliday (1904), in scarcely more than a single page gives a brief description of the gross features of the reproductive organs of the queen, and a statement that in workers no ovaries were found. The species described was *Eciton schmitti* Emery = *Neivamyrmex nigrescens* (Cresson). More recently, Marcus (1951, 1954) has published papers in which *Eciton* is treated rather briefly. He describes conditions in larvae and pupae, and suggests that early chitin formation may cause space limitations which prevent ovary formation in the worker castes, and discusses the functions of the corpora allata. He does not give much attention to the two species *Eciton burchelli* and *hamatum*.

Finally Hagan (1954) published a three-part paper describing and discussing the reproductive system of the army-ant queen (*Eciton burchelli* and *hamatum*), including also some notes on the structure of certain glands occurring in the gaster.

I am indebted to Dr. T. C. Schneirla of the Department of Animal Behavior, The American Museum of Natural History, for his cooperation with this study by furnishing for it large numbers of queens, males, and workers of *Eciton* species. These specimens were collected and preserved from colonies studied in field investigations by Dr. Schneirla on the behavior and biology of the army ants, supported through contracts with the Biology Branch, Office of Naval Research, and grants from the National Science Foundation. I wish, also, to thank Mr. G. W. Rettenmeyer of the Department of Entomology, University of Kansas, for much supplementary material.

MATERIAL AND METHODS

In the present study, only adult material is considered. Included are forty-four queens (five of which were labeled "callow") and several hundred workers. These workers include about equal numbers of minor, medium, and major individuals, with somewhat smaller numbers of soldiers. Many of the workers (in all forms) were also labeled "callow." A small number of mature males were studied; these are mentioned rarely in this report.

The specimens studied were collected by Dr. Schneirla mainly in Panama and in Trinidad. An enumeration of specific items, in the case of queens and males, with a report on the behavior and biological condition of the respective colonies prior to time of collection, will be found in Schneirla (1949), and in Schneirla and Brown (1950 and 1952).

For the most part, specimens were fixed shortly after capture. With some of the queens, however, laboratory study as live specimens delayed fixation by periods of from three to twenty-four hours. After fixation, all specimens were stored in a solution of 70% alcohol and 1% glycerine.

All material was fixed in a modification of Bouin's Picroformol fixative, changed at times to favor fixing of some particular structure. Fixation, in general, was satisfactory; poorer fixation occasionally occurred, possibly because the insects were kept under unnatural conditions for study prior to fixation. Material was prepared for study by being embedded, sometimes in celloidin, more frequently in paraffin. Dissections were also prepared. Staining was mainly with Heidenhaim's iron-alum-haematoxylin, occasionally with various counterstains.

ANATOMICAL DETAILS

Examination of a preparation of an *Eciton* queen, sectioned and stained for cytological study of cells in the reproductive system, showed many anatomical details that seemed unlike those recorded in other ants. This led to an extensive study of large numbers of specimens of the two species *Eciton burchelli* Westwood and *Eciton hamatum* Fabricius. This study included all stages: eggs, larvae on all instars, prepupae, pupae, and adults, with equal attention given to all castes of workers and queens. Smaller numbers of male larvae, pupae, and adults were also prepared.

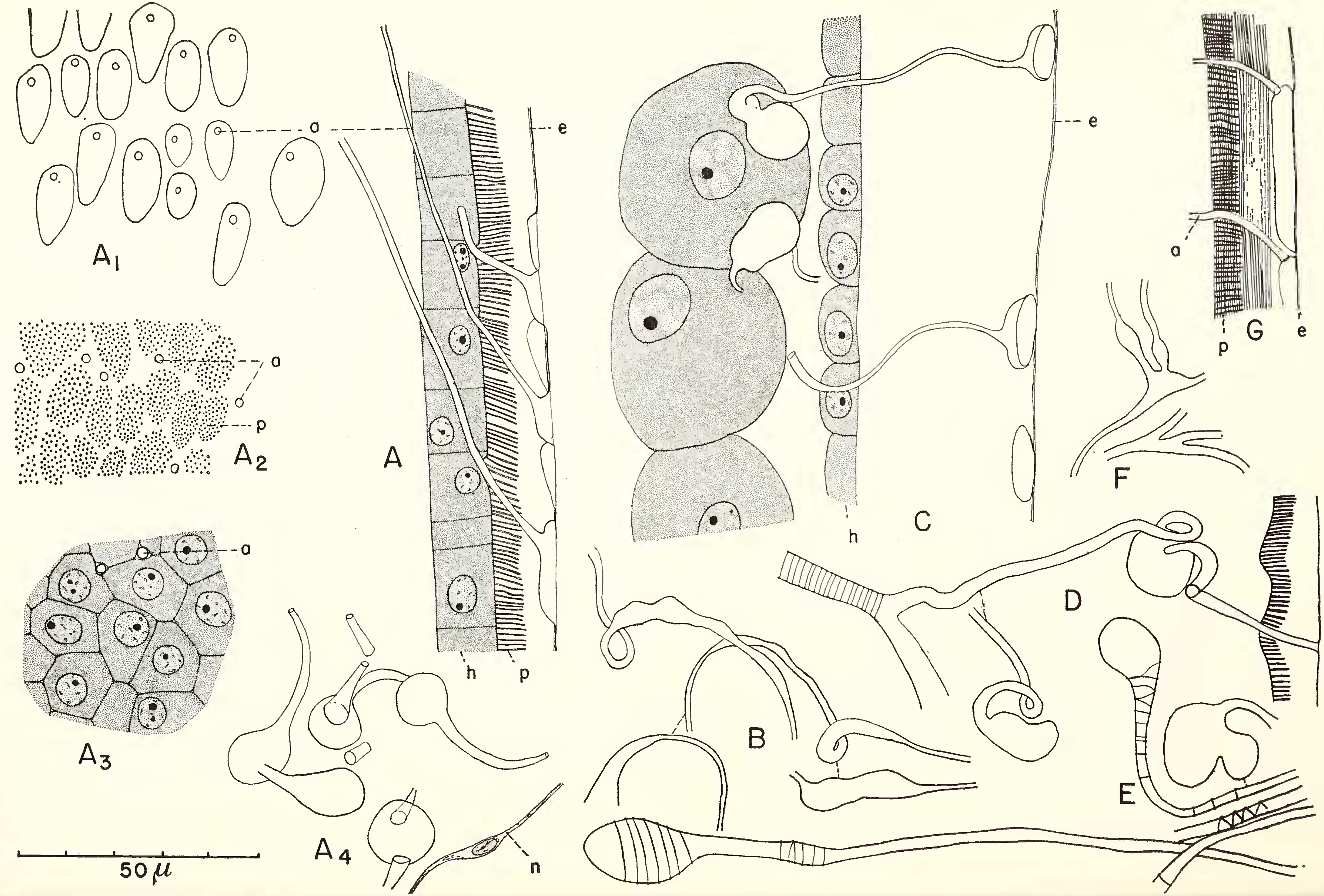
Body Wall

The body wall or exoskeleton of *Eciton* is neither unusually thick nor exceptionally hard, and may be easily cut into thin sections. Sections show clearly that there are two layers: the outer one (epicuticle) seldom less than one micron in thickness and the inner layer (cuticle) variable in both thickness and structure. The outer portion of this cuticle is homogeneous; the inner portion is characterized by the presence of large numbers of fine pores measuring 0.1–0.2 in diameter. The thickness of these two zones varies greatly; occasionally, the outer zone (exocuticle) includes as much as two-thirds of the total thickness of the body wall; especially in the head and thorax, the inner zone (endocuticle) is thicker, in some cases equalling three-fourths of the total thickness. Characteristically, the endocuticle is stratified, the strata varying in thickness. The presence of the many fine pores obscures the lines of stratification, but does not hide them completely.

Examination of a series of thin sections cut parallel to the outer surface of the body wall, shows much outer surface to be characterized by a mass of irregularly elliptical depressions separated by narrow ridges (Fig. 1, A_1). Sections immediately beneath this surface are homogeneous, excepting certain small pores presently to be mentioned. In sections at a still lower level in the wall, numerous fine pores appear (Fig. 1, A_2). They occur in elliptical groups, separated by narrow lines free from these micropores; these pore-free regions correspond to the ridges seen on the surface.

The body wall is pierced by a number of conspicuous canals through which fine nerves pass to the bases of the numerous spines that occur on the surface. These nerve canals are often irregular, some enlarging to diameters three to four times that found at their lowest point, then narrowing abruptly just beneath the base of the hair. Other nerve-canals make abrupt turns, so great that the mid-portion of the canal is at right angles to the inner and outer portions.

A second type of opening through the body wall in these two species of *Eciton* are relatively slender pores 0.75 to 2.4 μ in diameter (a in Fig. 1, A and $A_{1\text{-}3}$). The unguarded external openings occur singly in the depressions in the outer surface of the wall. The course of the pore through the wall varies greatly; some pass straight through, in a course perpendicular to the surface; some equally straight, pass at an angle as much as 30° to the surface; and some curve gently or strongly (a in Fig. 1, A, C, G). Emerging from the inner surface of the cuticle, these pores continue as thin-walled tubes between the cells of the hypodermis and into the body cavity. Within the cavity the lengths and nature of these tubes vary from 30 μ long to 2 mm. By far the greatest number of them become irregularly curved or angled. Invariably each tube enlarges to form a conspicuous chamber varying in shape from nearly spherical through variously elongated to ir-


A1
A2
A3
A4
A
B
C
D
E
F
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a
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50 μ

regular (Fig. 1, A_4, B, C, E). Occasionaly, two or rarely three chambers occur along a single tube. The chambers in *E. burchelli* tend to be more broadly rounded than those of the slender and fusiform *E. hamatum* (Fig. 1, A_4 and B). Often the tubes divide into two or sometimes three branches (Fig. 1, F). These tubes end internally in one of three ways: some anastomose; some end blindly in a terminal bladder (Fig. 1, E); and some join to a small terminal branch of the tracheal system (Fig. 1, D). This last occurrence suggests that these tubes are accessory respiratory organs, and might be named aeration tubes. In the tracheal tubes numerous, usually annular, thickenings occur on the inner surface (Fig. 1, D); thickenings occur rather sparingly on the walls of the aeration tubes, but always on the outer surface (Fig. 1, E).

These aeration tubes occur in certain regions only. In the head they are found in the antenna rarely, in the mandibles; in the thorax they are limited to the posterior aspect of the epinotal horns and to the legs. In the latter they are abundant, especially in the tibia and tarsal joints. They are abundant in the posterior aspect of the petiolar horns of the queen. They also

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Explanation of abbreviations: l.s. = longitudinal section; c.s. = cross section; t.s. = transverse section; s.s. = sagittal section; tg.s. = tangential section.

FIG. 1. Body wall and related structures.

- A l.s. of leg wall, *E. burchelli*
- A_1 Outer surface of leg with elliptical depressions, each with opening of an aeration pore (a)
- A_2 Inner surface of body wall showing groups of micropores (p) and aeration tubes (a)
- A_3 Hypodermis with aeration tubes (a)
- A_4 Leg beneath hypodermis with aeration tubes and chambers, fine nerve (n)
- B Leg of *E. hamatum*, cf A_4
- C l.s. pedicel wall, *E. burchelli* queen, left to right: oenocytes, aeration tubes and chambers, hypodermis (h), cuticle and epicuticle (e)
- D Tibia wall, *E. burchelli* queen, aeration tube extends from chamber, fuses with tracheal branch
- E Aeration tubes and chambers, *E. burchelli*
- F Tibia *E. hamatum*, branching aeration tubes
- G l.s. gaster wall, posterior-lateral region, aeration tubes (a), micropores (p), stratified endocuticle and epicuticle (e)

are found in the posterior segments of the gaster, where they are abundant only in the queen.

Excepting the areas where muscles have their origin and insertion, the hypodermis forms a continuous layer beneath the cuticle. The cells of this hypodermis are mainly prismoidal, varying considerably in thickness in different areas, but remaining constant in any one area (h in Fig. 1, A, C). The one area which is not constant is under the intersegmental membranes of the gaster of the queen. In virgin queens, the hypodermal cells are much like those under the cuticle of adjoining areas. With the advent of physogastry the intersegmental membranes are stretched greatly; as well as the cells of the hypodermis beneath the membranes, until they become little more than somewhat flattened nuclei held in an extremely thin layer of cytoplasm. When contraction follows an egg-laying period, instead of the membrane contracting elastically, it is thrown into a series of deep folds against which the hypodermal cells remain. In limited areas the cells become long, columnar, and often curved. Conspicuous among these are areas in the extreme posterior region of the gaster. (Fig. 8, D)

Lying beneath the hypodermis and somewhat removed from it are the oenocytes and the fat-cells. In callow individuals, both queens and workers, the oenocytes are so numerous that they form an almost continuous layer in many parts of the body, being conspicuous in several segments of the legs and in the gaster. These oenocytes are large and vary in shape from nearly spherical to broadly ellipsoidal or even slightly irregular. Each contains a single spherical nucleus. The chambers of the aeration tubes often occur in contact with an oenocyte, sometimes enough to form a depressed area in the side of the oenocyte.

Neither the muscles, the nervous system, nor the respiratory system of *Eciton* needs detailed description, being similar to the corresponding system described in other ants.

Upon comparing a muscle of *Eciton* with the corresponding muscle in *Myrmica* or any other ant and with the same muscles occurring in the several forms of *Eciton* the most obvious difference in the muscle is that of size. In large workers and soldiers the abductor muscle of the mandible is a very large muscle, its origin covering a large part of the posterior-lateral margin of the wall of the head, and narrowing gradually to its insertion on a prominent tendon that passes into the base of the mandible. In the medium worker, this muscle is much smaller than in the larger forms: in the smallest workers it is a small muscle, much smaller than is indicated by the comparative sizes of the heads. In the much larger queen this muscle, while large in comparison with that of the medium and small workers, is small and weak-looking in comparison with the muscle of the larger workers.

More noticeable is the difference between the sizes of the complex of muscles motivating the sting, which are conspicuously small in the queen, since the gaster has no room for large sting muscles.

In all forms, the ambulatory muscles of the thorax are large, the apodemes to which they are attached being noticeably so. There is no trace of flight muscles in the queens.

The Nervous System

There is great variation in the preservation of this system, especially noticeable in the queens. While preservation is excellent in many of the specimens, there are many in which it is decidedly indifferent. Because of this, it seems unwise to attempt comparisons which call for exact dimensions, especially of the brains. The approximate widths of the brains average as follows: minor workers 310 μ, medium workers 380 μ, major workers 450 μ, soldiers 600 μ, queens 850 μ, and males 450 μ. Several large nerves are conspicuous features of the head. The largest of these pass into the antennae and into the mandibles. In the queen, the most conspicuous nerve from the brain is the optic nerve, from 45 to 60 μ in diameter. The length of this nerve varies greatly. It may extend about half the distance from its point of exit from the brain to the body wall, or about 900 μ, the nerve thus ending about 100 μ from the cuticle. The distal part of this nerve narrows gradually to about one-half its maximum diameter at its other end.

The cortical tissue of the brain varies considerably in thickness in any given area. In old specimens of *Eciton,* it becomes very thin. The cells of the cortex are uniform in size, averaging 3–5 μ in diameter; rarely do larger cells occur, the largest measured being 19 μ long and 12 μ in diameter.

In the thorax, only the last of the three ganglia need be described. In the posterior thoracic ganglion, the medulla in the workers is separated into two distinct masses, in the queens into three, the posterior medullary mass being smaller than those before it. A small ganglion occurs in the petiole and the post-petiole of the worker and in the petiole of the queen.

The gastric ganglia of the queens are unlike those found in the workers. In the queen five large ganglia are found, the last of which has a medulla, apparently formed of two or sometimes three masses. This posterior ganglion occurs below the common oviduct, usually near its anterior end. The commissures connecting it to the ganglion before it are longer than those joining any of the other pairs of gastric ganglia.

In the workers, large and small, the entire chain of gastric ganglia is condensed into a mass of uniform diameter, occurring in the anterior half of the first, large gastric segment, its posterior end usually below the anterior half of the stomach. Longitudinal sections of this compound ganglion show the separate medullary masses of the ganglia. The nerves extending from this ganglion chain are extremely slender; those from the posterior end usually appear as straight fine lines extending back to the tissues in the posterior part of the gaster.

The corpora allata are small ovoid bodies occurring under the posterior portion of the brain. Their dimensions vary, from 50–70 μ in length and from 30–80 μ in diameter. Some are nearly spherical, others twice as long as their greatest diameter. They usually contain 10 or 12 nuclei, measuring 7–9 μ by 10–12 μ which are uniformly spaced in the body.

In the queen the walls of the large, irregular trachea of the gaster vary considerably during the change from completely contracted individuals to those fully physogastric. These walls appear non-elastic, though flexible. This results in the occurrence of a complex type of folding of the walls of the larger tracheal tubes when the gaster is contracted. There is also a certain increase in diameter of the main tracheal trunk in the gaster when physogastry begins. Maximum diameter is reached well before physogastry is advanced, when presumably maximum division and early growth of the cells of the ovarioles occur. As peak physogastry is approached, the diameter of the tracheal trunk decreases noticeably and remains fairly constant for the duration of maximum gaster size.

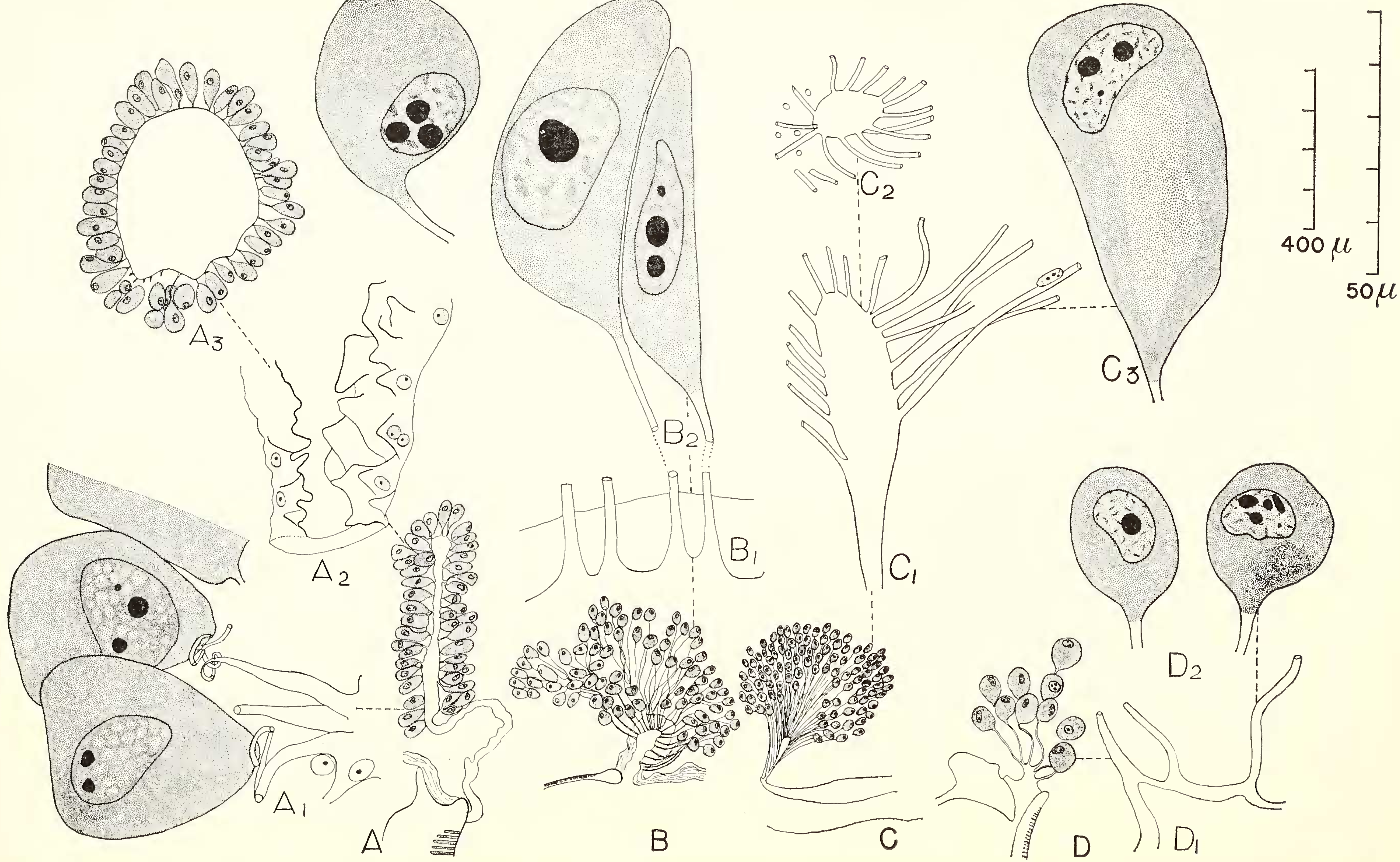
THE DIGESTIVE SYSTEM AND RELATED STRUCTURES

The mandibles, whether they are the broadly triangular coarsely toothed ones of the workers or the curiously long hooked ones of the soldiers consist of five tissues. These are the hypodermis, which forms a thin continuous layer against the inner surface of the membrane joining the cuticle of the head and that of the mandible; a small tracheal branch; the tendons of the mandibular muscles, which are inserted on the walls of the mandible near its base; the large nerve which extends to the apex of the mandible, giving off numerous slender branches to the many hairs occurring on the surface of the mandibles; and the anterior end of the chamber of the mandibular gland (Fig. 2, A).

In all forms of the two species of *Eciton* considered here, the mandibular gland has a structure so characteristic that even small bits are easily recognized. In shape and in size, there is much variation, especially in the chamber. Typically it is elongate, irregular object narrowing gradually as it nears the base of the mandible. Passing into the mandible, it turns abruptly outward to end in a small elliptical pore through the thick wall of the mandible. These elongated forms measure about 1000 by 160 μ in queens, 530 by 70 μ in soldiers, and 200 by 48 μ in small workers. Measurements may however, be misleading, for in any single form this gland chamber may be about 350 μ long, with the maximum diameter varying from 75 to 320 μ. This maximum may be found near the apex, near the middle, or in rare cases near the base or anterior end, not far from that point where it narrows to pass into the mandible. Conceivably the gland may change considerably in size and in shape as the secretions of the cells accumulate or are used. In extreme cases the main part of the gland chamber may be nearly spherical, and about 300 μ in diameter. While this spherical shape may occur in all worker forms, it occurs most often in the minor workers.

This gland characteristically varies in the anterior portion of the chamber, where it usually becomes a narrow tube. This is seldom a straight tube; the most common variant is one having two abrupt turns of about 90°; in some cases the turns are so extreme the narrow portion shows three nearly parallel sections.

In the males, the posterior end of this gland is frequently bifurcate, the two short coarse branches passing one above, the


A3
A2
A1
A
B2
B1
B
C2
C1
C3
C
D2
D1
D
400 μ
50 μ

other below the large optic nerve. Occasionally the gland is deflected sharply to pass either above or below this nerve.

The ducts of the many secretory cells open into the chamber of the mandibular gland. These openings often occur singly and are evenly spaced. Occasionally, in the queens and largest workers, the openings of several ducts occur so closely, a conspicuous conical evagination of the chamber wall is formed.

The ducts of this gland are 20–65 μ in length, scarcely 1–2 μ in diameter at the apex and gradually increasing to a diameter of 4–6 before enlarging abruptly as they open into the chamber. At the upper end, each duct is usually irregularly coiled, another indication that emptying of the chamber causes adjustment of the ducts opening thereinto (Fig. 2, A_1).

The secretory cells vary greatly in size and in shape; a long narrow one may measure 85 by 28 μ; a short broad one, 43 by 38 μ. Some are spherical, some pyramidal, and many irregular. The single nucleus in each cell may vary from spherical to irregularly flat (Fig. 2, A_1). The number of secretory cells in a gland varies from a minimum of 100 to a maximum over 1400.

Extending from the mandibles to the bases of the mouth parts and around them, is a membrane in which the openings of the ducts of three glands are found. The first of these is a small gland comprising three or four to twenty or more cells and their ducts; the latter open near the base of the mandible. The sec-

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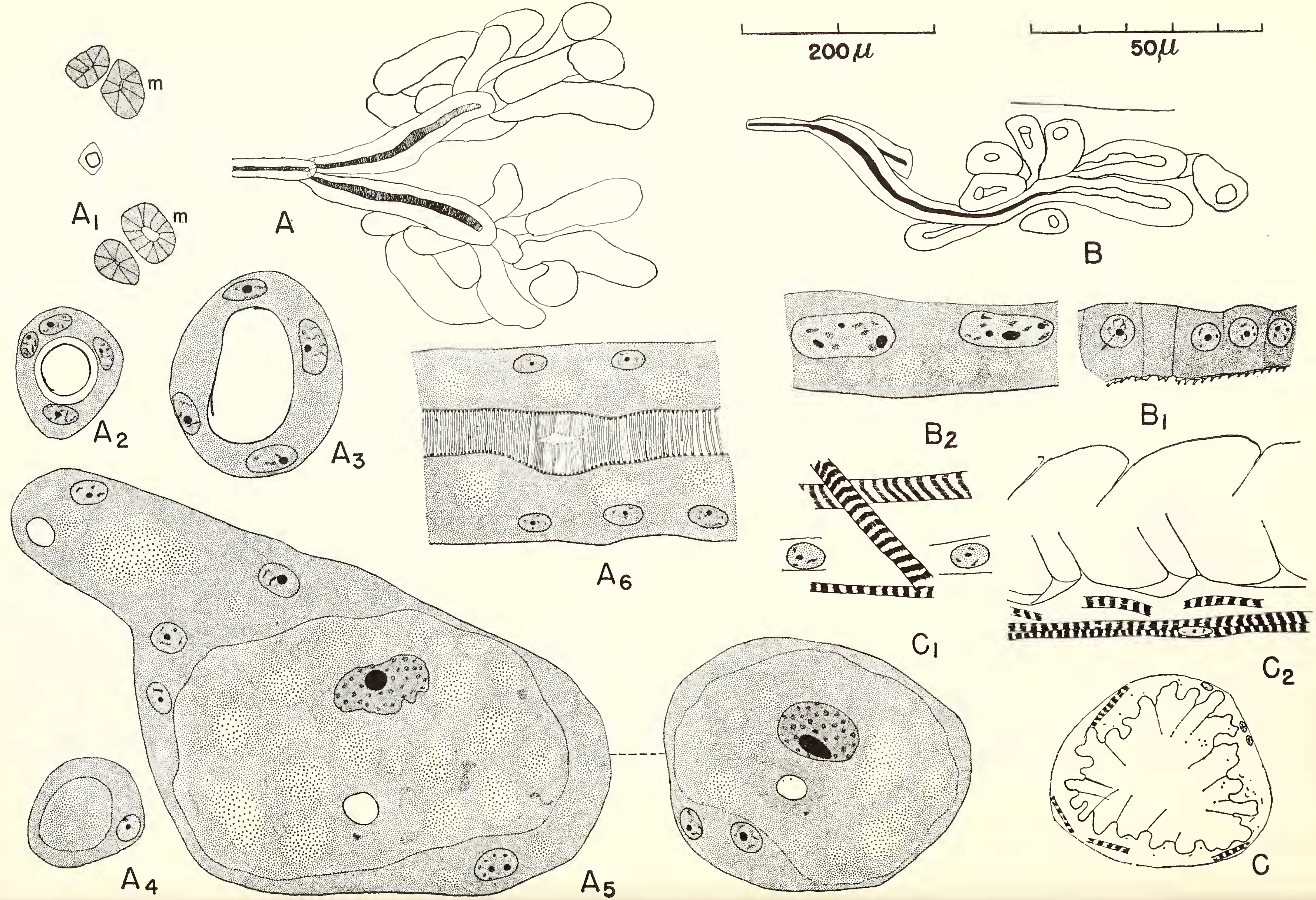
FIG. 2. Glands in head (anterior).

A Mandibular gland of major, *E. burchelli,* wall of mandible at base, chamber and cells of gland
A_1 Cells and ducts of medium worker
A_2 Wall of chamber of gland, below secretory portion, showing nuclei
A_3 t.s. of secretory portion
B "Intermediate" gland, between mandible and mouth parts
B_1 Duct openings
B_2 Secretory cells in a major of *E. burchelli*
C Maxillary gland of *E. burchelli* queen
C_1 "Chamber" of gland, with ends of ducts
C_2 t.s. of chamber
C_3 Secretory cell of gland
D Gland at tongue base of medium worker
D_1 Duct openings of gland
D_2 Secretory cells
Scale: A, B, C, D—50 μ scale, other parts—400 μ scale


200μ
50μ
A₁
m
m
A
B
A₂
A₃
A₆
B₂
B₁
C₁
C₂
A₄
A₅
C

ond gland is large and its secretory cells number 30–50 in the smaller worker forms and about 300 in the queens (Fig. 2, B). Exact counting is difficult, since the cells of this gland and those of the maxillary gland occur in a confused group with no region of separation; only by tracing the ducts can one determine to which gland the cell belongs. These ducts vary greatly in length; those of the cells nearest the membrane may be as short as 8 μ, while some of the remote cells have ducts over 30 μ long. Transition from the base of the cell to the duct is usually gradual, with the diameter of the ducts a fairly constant 2–3 μ (Fig. 2, B_2). Some of these ducts open singly through the membrane (Fig. 2, B_1), while many form compact groups opening through the walls of a conical invagination of a part of the membrane. The secretory cells of this gland have the same nuclear variation and size and shape range as was noted in the cells of mandibular glands. The third gland, occurring at the base of the mouth parts, is a small one, the total number of its cells is seldom more than fifteen to twenty (Fig. 2, D, D_1, D_2). The cells are smaller than those found in the previous glands, and of uniform broadly oval shape averaging 28–30 μ by 22–24 μ. The ducts of this gland are much shorter than those found in the other glands rarely measuring more than 4–7 μ.

FIG. 3. The salivary gland and oesophagus.

A Salivary gland, showing ducts and secretory branches in thorax

A_1 t.s. duct in tongue, near opening, with muscles (m) to palps

A_2 t.s. of duct posterior to tongue

A_3 t.s. of duct below brain

A_4 Secretory portion, near apex of branch in worker

A_5 Secretory portion in queen

A_6 l.s. of duct in thorax, prior to duct merger from opposite side

B l.s. of one side of secretory portion and ducts of salivary gland in thorax of worker minor

B_1 Dorsal wall of duct, near secretory portion, with large nuclei

B_2 As above with small nuclei

C Oesophagus, t.s., in mid-thorax *E. burchelli,* showing muscles and spines

C_1 l.s. of outer part of oesophagus showing irregular musculature

C_2 l.s. of oesophagus, showing muscles and wall, with spines of upper and lower surface of wall

Scale: A and B—200 μ scale; others 50 μ scale

Detailed examination of the mouth parts was not made in this study. The several muscles found in them, even though small, are more robust in *Eciton* than in many other ants, and have prominent striations. Of greater interest is the salivary (labial) gland (Fig. 3), the duct of which opens at the base of the tongue. This opening may be a transversely elongated slit or broadly elliptical; the relative position of the tongue determining the shape of the opening. When circular, the opening is 3 μ in diameter in small workers and 5–6 μ in the queens (Fig. 3, A_1).

The duct of the salivary gland as it leaves the base of the tongue is about 4–5 μ in diameter in the several forms, with the lumen 0.5 μ in diameter (Fig. 3, A_2). The inner wall bears evenly spaced low annular thickenings. As it passes posteriorly through the head (Fig. 3, A_3) and into the anterior thorax, the duct gradually enlarges to 35 μ in diameter, with its central lumen increasing to 18 μ. At the same time the discoid nuclei occurring in the wall of the duct increase from 4–5 by 2.5–3 μ to 11 by 4.5–5 μ. Passing through the head, this duct may pass down nearly to the lower wall of the head or it may be almost in contact with the brain.

Passing into the thorax, the diameter of the duct continues to increase to 40–50 μ, with the central lumen tending to decrease to 14–16 μ and to vary from one point to another (Fig. 3, A_6). Presently the duct divides into two equally large, thick-walled branches which gradually separate to opposite sides of the anterior thorax (Fig. 3, A). There it gives rise to several short, thick, irregular branches which are the secretory part of this gland (Fig. 3, B). In the queens, the total length of this part of the gland is 1.5–3 mm.; in small workers, about 0.5 mm. The diameters of these branches vary from 55 to 80 μ, in a single queen, with the central lumen about 6 μ in diameter. In this portion, there are many large nuclei of irregular shape measuring 32 by 10 μ. Peripherally there are many small, usually spherical nuclei 5–7 μ in diameter (Fig. 3, A_5). Membranes separating this secretory portion of the gland into cells can only rarely be discerned.

In the various worker forms, the salivary gland is smaller in every dimension, but has about the same appearance (Fig. 3, A_4).

Just above the bases of the mouth parts, the opening into the infrabuccal pocket is found. In all the queens examined, the walls of this pocket are collapsed so that practically no cavity remains. Nor was there any sign of any content therein. The inner surface is characterized by a reticulation of shallow grooves. Over much of the inner surface of the pocket, the elevated areas formed by the grooves are smooth. But in a small area of the ventral surface, near the entrance to the pocket, the posterior part of each elevation is usually armed with a row of 8–12 short acute spines.

In the workers the infrabuccal pocket is always tumid, with the entire inner surface covered with closely set rounded bosses, the upper part of which bears many slender bristles. In nearly all individuals, from minor workers to soldiers, the pocket is filled either completed or partially with a mass of small particles. In these masses, insect material including joints of legs and pieces of antennae is frequent and easily identified as such; bits of animal material other than insect can occasionally be recognized; vegetable material occurs infrequently. This material is usually a loose mass; rarely pressed into a compact mass identified as a pellet, perhaps ready to be ejected.

Above and close to the entrance to the infrabuccal pocket is the mouth. This is always a transversely elongated opening, the margin of which is armed with a mass of thickly set stout, curved spines. Similar spines are found for a short distance into the mouth cavity. The transition from this buccal tube to the pharynx is not sharp and it is sometimes difficult to decide just where the change occurs.

From each lateral margin of the buccal tube, at approximately the junction to the pharynx, a slender diverticulum extends backward and inward somewhat above the infrabuccal pocket (Fig. 2, C). This diverticulum in the queens may be cylindrical or, more frequently, club-shaped; in workers it is usually a slender conical object. In both queens and workers, its shape is usually obscured by the occurrence of many small irregular diverticula from its surface. The total length may be 100–120 μ in queens, but shorter in the workers; its diameter is usually 15–20 μ in queens, less in workers.

Through the walls of these diverticula, the ducts of the cells of the maxillary glands open. In some individuals the duct openings occur irregularly over the entire surface; in others, and especially in the queens, two to many ducts may open so closely together that their union forms a secondary diverticulum from the main one. Often these secondary diverticula are so numerous that the main one appears to be irregular, and repeatedly branched.

The ducts are uniformly slender, seldom as much as 1 μ in diameter and variable in length, the shortest being those going to cells located near the wall of the diverticulum, the longest up to 40 μ long to reach cells near the margin of the gland.

The total number of cells in each of the paired glands varies from 200 to 320 in the queens, many less in the workers. Some are elongate, some nearly spherical, and many irregular. Samples of dimensions are 80 by 22 μ, 65 by 60 μ, 50 by 50 μ, 60 by 45 μ in queens; 27 by 17 μ to 25 by 22 μ in workers. In nearly all individuals the cells are closely aggregated and it is often difficult to find any line of separation between the two glands. Furthermore, they are in no way distinct from those of previously described glands. Often there appears to be a single compact gland extending from the base of one mandible all the way across the front of the head to the base of the other mandible.

(To be continued)

DEFORMITIES OF EXTERNAL GENITALIA IN SPIDERS

B. J. Kaston
Central Connecticut State College
New Britain, Connecticut
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ABSTRACT

Brief descriptions are given of 14 cases in which the epigynum or the palpus is deformed. It is suggested that for the most part these stem from accidents during the molting process, or to imperfect regeneration of a part lost between molts.

Ordinarily one may expect to find abnormalities of the genitalia in spiders that are gynandromorphs or intersexes, and cases of these latter have been summarized by Kaston (1961). Also, there have been a few cases of duplication of the epigynum